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Editor :

PROFESSOR T. DALLING, M.A., M.R.C.V.S.,
Professor of Animal Pathology and Director of The Institute of Animal Pathology, Cambridge University

Sub-Editor :

PROFESSOR J. McCUNN, M.R.C.V.S., M.R.C.S., L.R.C.P.,
Professor of Anatomy, The Royal Veterinary College

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Editorial

THE veterinary profession is included in the Schedule of Reserved Occupations and therefore its sphere of activities at this time of national emergency is limited. Up to the present there has been no express demand for its services in the carrying out of any special duties except in the comparatively few instances when members of the profession have been called upon to attend to casualties among animals consequent upon enemy action. It is important that there should be available an adequate number of our members to deal with extensive outbreaks of any contagious disease which may gain a footing at any time. We feel, however, that much more use can and should be made of the profession now in controlling the various diseases of livestock which cause so much economic loss and therefore constitute a weakness in the national defence of the country. In previous issues we have drawn attention to some of the diseases which are capable of being controlled and we now urge that careful consideration be given to this subject by the various interested bodies and departments concerned with the maintenance of our food supplies. It is only necessary to mention the immense losses in milk, meat and in animals themselves consequent upon the prevalence of diseases such as contagious abortion, mastitis and sterility and other conditions in dairy herds, and the various diseases of sheep, pigs and poultry, many of which are preventable or can be controlled. Following upon the experiences before and during the Great War and on the recom-

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mendations of the various committees who have examined the position of diseases of livestock in the country, considerable impetus was given to the carrying out of research work into the most important diseases responsible for wastage in the herds and flocks in the country. While, in some cases, the researches are still in progress, it must be admitted that our knowledge of the causes and methods of control of many of these all-important diseases has reached such a stage that it can be brought into practice with every confidence that by application of suitable methods of control losses can be very considerably reduced. What is required immediately is some organisation whereby the veterinary profession will be brought into close contact with the owners of the animals; by their collaboration it will be ensured that the control of the various diseases will be commenced without delay. No scheme for the control of such diseases can be successful without the keen interest of the stockowner himself. There must now be an extensive campaign by means of which agriculturists will be made acquainted with all that can be done in the control of the diseases of their animals. If the various members of the veterinary profession have not the knowledge of the latest and most efficient methods of disease control, steps should be taken at once to ensure that such information is acquired. There are members of the profession and others who have made extensive study of these methods and who can be used now to acquaint the less-informed members of the profession with the various specialised methods of treatment. The veterinary practitioners must have access to the diseased animals and must ensure that only the most up-to-date and efficient methods of treatment and control are adopted; their experience will enable them to decide on the most suitable methods to practise under the conditions on the various premises.

There can be no doubt whatever concerning the success of a scheme whereby this collaboration between the two important and essential bodies concerned—the livestock owners and the veterinary profession—is practised to the fullest extent. The country at this time demands that measures be taken to control wastage in the herds and flocks. The agriculturists and the veterinary profession must get together without delay and devise a workable scheme for the control of the diseases causing wastage and when the scheme has been devised it must be put into operation at once and carried out to the bitter end.

As stated in the July number, it was decided not to issue a number of THE VETERINARY JOURNAL in August, but to combine the August and September numbers. From October onwards we shall revert to the issue of the usual monthly numbers of the Journal.

General Articles

SWAYBACK STUDIES IN NORTH DERBYSHIRE

II. The Relationship of the Storage of Copper and Lead in the Body Tissues to the Causation of Swayback*

By G. D. SHEARER, J. R. M. INNES and E. I. McDOUGALL

Institute of Animal Pathology, Cambridge University.

THE paper by Dunlop, Innes, Shearer and Wells (1939, I) gave the results of a large-scale feeding experiment in North Derbyshire which was designed to extend previous observations on the feeding of Cu supplements, a preventative of Swayback of new-born lambs (Bennetts and Chapman, 1937, and Dunlop and Wells, 1938). An opportunity was also provided for more extensive chemical and hæmatological work. Earlier work along these lines was begun in 1938; Innes and Shearer (1940) had indicated that this was necessary to obtain a better understanding of the exact role played by copper in the disease process.

The plan of the field experiments may be briefly recapitulated. The main experimental area consisted of four separate fields covering an area of nearly 300 acres. The ewes were divided into four groups—two to act as controls and two to receive Cu supplements as pure salt licks† containing 1 per cent. and 0.3 per cent. Cu, as $CuSO_4$ respectively, throughout pregnancy. One of the control groups (A) was kept until near lambing in a field about one mile away from the main area. Ewes in the Cu treated groups were drafted in numbers on to the Cu lick treatment at different periods of pregnancy which corresponded roughly to 12, 10, 7 and 4 weeks before lambing. These groups, the numbers of ewes in each group and the number of swayback lambs and their mothers are referred to in Table I.

* In the paper dealing with the first part of this investigation, Dunlop, Innes, Shearer and Wells, *J. Comp. Path.* (1939), *52*, 259, an error was made in the references where reference was made to a communication by Innes and Shearer, *J. Comp. Path.* (1939), *52*, 259. This paper was held up until the following number of the Journal. The corrected reference is: Innes and Shearer (1940), *J. Comp. Path.*, *53*, 1.

† The Cu licks were examined spectroscopically by Dr. R. L. Mitchell, of the Macaulay Institute for Soil Research, Aberdeen. No evidence of contamination by other trace elements was found.

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TABLE I.

Group		No. of ewes	Cases of swayback	No. of ewes with swayback lambs
Control A	...	40	24	16
„ B	...	40	12	10
Total	...	80	36	26
C treated 1% Cu from:				
23.12.38	...	15	0	0
11. 1.39	...	10	0	0
1. 2.39	...	11	1	1
23. 2.39	...	10	1	1
Total	...	46	2	2
D treated 0.3% Cu from:				
23.12.38	...	32	0	0
11. 1.39	...	15	1	1
1. 2.39	...	16	4	3
23. 2.39	...	18	8	6
Total	...	81	13	10

Lambing began on March 13, 1939.

The purpose of the work embodied in the present paper may be briefly summarised:

(A) To find out whether ewes, which gave birth to "swayback" lambs, were themselves suffering from a macrocytic hyperchromic anæmia. This was reported originally by Bennetts and Chapman (1937) in Australia to be the immediate result of "copper deficiency" and to form a syndrome with the cerebral disease in the lamb. No explanation, however, was given regarding the genesis of this "blood-brain" complex.

(B) To study the relationship of the storage of Cu in the ewe to that in the lamb, and the effect of copper treatment on the body reserves and to the development of the disease. It was already pointed out that although a prophylactic treatment had been discovered, little was known regarding the mode of action of the trace element. In addition, Innes and Shearer (1940)

had shown that lead could not be summarily dismissed as of no etiological significance mainly because of the large amounts of Pb found both in the pastures of this Derbyshire area and in the body tissues of affected lambs and their mothers. More chemical data were also required regarding this aspect.

Most of the ewes were bled (a) in November, 1938, about the beginning of pregnancy, before the actual experiment had begun; (b) in January, 1939, about halfway through pregnancy, and (c) in March and April as soon after lambing as possible. Blood was drawn by venepuncture from the jugular vein into carefully cleaned bottles containing Cu- and Pb-free potassium oxalate as anti-coagulant. Certain hæmatological examinations were carried out immediately and the blood was stored for subsequent chemical examination. All lambs which died or were killed because of "swayback," or which were stillborn, were autopsied. From a number of the affected lambs samples of blood, liver, brain and ribs were taken and preserved for chemical examination. Some normal control lambs, some ewes which had given birth to "swayback" lambs and some ewes which had given birth to normal lambs were killed at the conclusion of the experiment and body tissues were also preserved for chemical examination.

The liver and brain were dried in the hot air oven at 98° C. and stored; the bones were freed from all paraosteal tissue, ashed in a muffle furnace at a low temperature, ground and stored. In the chemical analyses, Cu was estimated by the diethyldithiocarbamate, and Pb by the dithizone methods; these had previously been found to be satisfactory.

Samples of grass were collected in November, 1938, and January, 1939, from the various field on the experimental ground, and analyses were made of Cu and Pb. These were carried out by Mr. R. Sutton, County Analyst, Derby. No special care was taken to collect the grass for analysis entirely free from soil, as a more accurate assessment could be thus made of the actual Pb and Cu intake of the ewe.

As the detailed results of the chemical and hæmatological analyses are so extensive, and as the variation in each section is so small, only the means and standard deviations have been published. These full tables are preserved in the records of the Institute and can be obtained for perusal on request.

Results

1. Hæmatological Work.

In a previous paper we stated that the investigations of 1938 did not confirm the suggestion of Bennetts, that a macrocytic hyperchromic anæmia occurred in ewes which gave birth to swayback lambs. Nevertheless, a large-scale experiment such as this provided abundant scope for further confirmation of our conclusions. We had, however, found previously that a number of ewes in the Derbyshire area did show relatively low red cell counts and hæmo-

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globin values. It was intended, therefore, to determine, if possible, the cause underlying this condition.

With such a large number of sheep to be examined, work on each of the animals had to be limited to the bare essentials.* The hæmoglobin in the blood of each animal was determined before the experiment began in November. From a number of animals in each group, particularly those showing relatively low hæmoglobin values, further examinations were then carried out (red cell count, cell volume and smear examination). Similar examinations were subsequently made in January and in April. In this way the anæmic ewes were detected and followed up further if necessary. It was also hoped to determine the effect of copper treatment on the blood.

The findings were largely negative, and it is considered adequate if our findings and conclusions are summarised. Emphasis may be made again of the great variation of hæmoglobin values and red cell counts of sheep of different ages which were apparently in good health and able to withstand the rigours of pregnancy.

The results of this experiment provided abundant confirmation of our previous opinion that an anæmia comparable to pernicious anæmia of man does not occur in ewes which give birth to swayback lambs. This negative finding must be emphasised because of the implications in another direction. By far the larger number of ewes giving birth to swayback lambs showed relatively no deviation in the blood picture from normal standards in this region. Both in the control and Cu treated groups a number of ewes which gave birth to normal and swayback lambs did, however, show relatively low red cell counts and reduction in the hæmoglobin. Macrocytosis was absent and again we had no evidence that the anæmia was even hyperchromic. Further proof that this anæmia was not comparable to pernicious anæmia of man was obtained during this period when a gastric analysis of one such anæmic ewe showed no evidence of achylia. Stomach contents were obtained for periodic analysis through an abomasal fistula. This work was done by Mr. A. T. Phillipson, of this Institute. We were unable to determine the actual cause of this anæmia, but many of these animals were in extremely poor condition and pastured in an area notorious for its poor herbage. Similarly, we were able to confirm that, provided swayback lambs were examined soon after birth, the red cell count and hæmoglobin were well within normal limits.

In connection with these conclusions it is relevant to note that more recently Marston (1939) pointed out that "the anæmia" (originally reported in Australia as a specific complex in ewes with swayback progeny) was in reality merely a symptom coincidental with cobalt deficiency. He stated that in areas of Australia where there occurred both swayback and "coast disease" of the ewes, either of these could be eliminated by the feeding of copper or

* The technique adopted was given previously, Innes and Shearer (1940).

cobalt respectively to the ewes, to leave the other uncomplicated syndrome of either deficiency. In any case, further confirmatory proof that the anæmia of ewes in Australia, described by Bennetts as being comparable with pernicious anæmia of man, has not been forthcoming.

The non-specific " anæmia," occasionally observed in the Derbyshire ewes, is almost certainly not due to lack of cobalt because spectroscopic examination of samples of grass in this area showed no deficiency of this trace element.

All the work done in this country indicates, therefore, that there is no connection between the occurrence of a hæmatopoietic disturbance in the ewe and swayback in the lamb, certainly not in the sense of a syndrome parallel with pernicious anæmia and subacute combined degeneration in man which was originally contended by Bennetts in Australia.

2. The Role of Pb in the Ætiology of Swayback.

(a) *Pasture analyses.*

The level of Pb in the grass of the fields in the two areas on which the experiment was carried out is given in Table II. For convenience the Cu content is also given in the same table.

TABLE II.

Mg. per 100 g. dry grass.

Date when sample taken			Field 1	Field 2	Field 3	Field 4	Field away from main area
25.11.38	Pb	...	4.5	3.7	5.8	4.0	7.0
„	Cu	...	1.3	0.85	0.8	1.0	0.95
23. 1.39	Pb	...	21.5	19.6	9.6	8.5	35.2
„	Cu	...	1.8	1.3	0.8	1.2	1.7

It should be emphasised that the level of Pb in the grass of these experimental areas is considerably higher than in areas outside Derbyshire where no swayback occurs (see Innes and Shearer, 1940). It is also apparent that the Cu and Pb content of the grass increased from November to January, but that the Pb increased to a much greater extent than did the Cu. The data, however, are much too scanty from which to draw any definite conclusions.

Dr. R. L. Mitchell, of the Macaulay Institute for Soil Research, examined spectroscopically some samples of grass which were gathered from affected areas in Derbyshire in 1938. He found that the grass contained normal amounts of the trace elements and high amounts of lead, but he also found unusually high levels of zinc. No grass from the area in which we worked in 1939 was forwarded to him for examination, but it is unlikely that this will differ very much from the samples already examined. As so little is known about the effect of absorption of zinc in farm animals it is not proposed to discuss its significance here.

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(b) *Tissue analyses.*

The results of the Pb analyses of the blood, liver, brain and bones are recorded in Table III.

It can be seen from the table that the levels of Pb in the tissues of unaffected and swayback lambs and of unaffected and affected* ewes in this area show no significant differences; these figures must, however, be regarded as high.

Comment on the Role of Lead.—It is obvious that the sheep in this area are ingesting a large amount of lead, which is reflected in the high level of Pb in their tissues. There is no evidence, however, that the sheep on this experiment, or indeed any sheep in this area, ever suffer from plumbism, although it is well known to occur in horses and poultry. The reason for this apparent innocuous action of the metal for the sheep is not clearly understood.

In a previous experiment on the toxic effect of lead on ewes it was found that the administration of 0.5 g. of lead acetate daily by mouth caused death in 45 days. This represented the ingestion of about 270 mg. of lead per day. To ingest this amount of lead in the Derbyshire area and assuming that the ewe eats about 3 lb. dry matter per day, it would be necessary for the ewe to eat grass containing about 20 mg. of lead per 100 g. of dry grass. This figure was equalled by one and exceeded by another sample of grass in January (see Table II). Nothing is known about the availability to the organism of lead in grass, but it is unlikely that it is as easily absorbed as that from lead acetate. Contamination of the grass with soil containing lead would probably be in the form of the sulphide which has been shown to be well tolerated by farm animals (Miessner, 1927). The sheep in this area must, however, be ingesting what, to all intents and purposes, represents a toxic dose of lead relative to that of lead acetate.

Tompsett (1939) has shown that in mice the absorption of lead from the alimentary tract was not influenced to any great extent by the amount of lead given when the animals were on a high Ca diet. On a low Ca diet, however, the amount of Pb absorbed was increased and was directly related to the amount administered. Tompsett and Chalmers (1939) found that the feeding of a low Ca diet to patients suffering from lead poisoning resulted in a rise in the blood Pb without evidence of increased excretion, whereas a high Ca diet brought about a fall. It has been shown that grass in this area contains a high proportion of Ca (Innes and Shearer, 1940); in view of Tompsett's work, this might reduce the normal absorption of lead from the grass.

So little is known, however, about the effects of lead on sheep that it is

* It is proposed to describe ewes in this area which gave birth to lambs unaffected with swayback as "unaffected" and those which gave birth to swayback lambs as "affected." It is felt that because all sheep in this area have such a low level of Cu in the blood and probably in the liver they can hardly be described as normal.

premature to draw any conclusions from work which has been conducted on laboratory animals and human beings.

It may be concluded, however, that any toxic effect of lead in these ewes could only be of a very chronic nature, but there is no evidence to indicate the occurrence of even this insidious form of plumbism. There is thus further justification for assuming that lead is not concerned in the production of the disease unless it plays a peculiarly obscure and as yet undiscovered secondary role.

TABLE III.

Cu and Pb content of Tissues of Lambs and Ewes.

For liver and brain the results are expressed as mg./100g. dry tissue.
Ribs „ „ „ „ „ mg./100g. fresh bone.
Blood „ „ „ „ „ mg./100c.c. whole blood.

The figures in brackets refer to the number of ewes or lambs examined.

LAMBS.		Copper mg. per cent. Unaffected.	Copper mg. per cent. Affected.	Lead mg. per cent. Unaffected.	Lead mg. per cent. Affected.
Liver	Mean	1.84(31)	1.48(13)	2.3(35)	1.2(11)
	S.D.	±0.72	±0.19	±2.0	±0.9
*Liver from lamb in normal area		11	—	—	—
Brain	Mean	0.75(30)	0.84(9)	0.16(29)	0.22(7)
	S.D.	±0.30	±0.18	±0.08	±0.07
Ribs	Mean	—	—	0.94(9)	1.17(9)
	S.D.	—	—	±0.42	±0.24
Blood	Mean	0.091(9)	0.071(9)	0.058(6)	0.024(8)
	S.D.	±0.026	±0.016	±0.025	±0.007
†Blood from lambs in Cambridgeshire.	Mean	0.23(8)	—	0.024(6)	—
EWES.					
Liver	Mean	1.6(8)	1.93(2)	0.7(4)	2.4(2)
	S.D.	±0.62	1.9 & 2.0	±0.14	3.0 & 1.7
*Liver from ewe in normal area		32	—	—	—
Brain	Mean	0.73(5)	0.71(2)	0.14(5)	0.11(2)
	S.D.	±0.01	0.68 & 0.74	±0.015	0.11 & 0.12
Ribs	Mean	—	—	3.6(2)	2.9(2)
	S.D.	—	—	5.8 & 1.9	2.5 & 3.3
Blood	Mean	0.084(153)	0.074(38)	0.019(6)	0.022(6)

* Quoted from Cunningham (1931).
† Personal observation.

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3. The Effect of Feeding Cu on the Cu Reserves of Ewes and Lambs.

(a) *The blood Cu of untreated control ewes giving birth to normal lambs.*

The blood Cu of the ewes in the two control groups increased with the advance of pregnancy, but this increase was of a different character in each group. No difference was present between the two groups at the beginning of the experiment, but with the advance of pregnancy the rise of the blood Cu in the ewes of Group A was more marked from November to January than from January to April; in the ewes in Group B the increase was confined to the January to April period. This difference is difficult to explain. The animals in Group A were pastured in a field away from the main area; the Cu content of the grass in this field increased to a greater extent than that of the main area in which Group B were pastured (Table II). Assuming that a fair sample of grass was collected from these fields and that a ewe consumes about 3 lb. of dry matter per day, the ewes of Group B were ingesting in January about 23 mg. Cu daily, compared with about 18 mg. by those in Group B. Little is known regarding the effect of slight increases in the dietary Cu on the blood, so it cannot be deduced that this small increase of Cu ingested by the ewes in Group A from the grass was sufficient to cause the greater rise from November to January in the blood Cu of this group than in that of Group B. Eden (1939), however, has shown that in ewes in Northumberland a moderate increase in the Cu intake does not materially increase the normal blood Cu level. In spite of the difference between these two groups from the November-January period, the ultimate levels of the blood Cu of the ewes in April after lambing were similar.

(b) *The blood Cu of ewes receiving Cu treatment and which gave birth to normal lambs.*

The increase of blood Cu as pregnancy advanced was more marked in Groups C and D than in A and B. The final figures in April, after lambing, in the various sub-groups, were similar irrespective of the length of time during which Cu treatment had been given, but the blood Cu of Group C rose to a higher level in April than that of Group D. The increase from November to January was significant only when the Cu licks were given from December, no increase, for example, being found in January in those sub-groups where the appropriate licks were fed only for a short time before bleeding.

(c) *The blood Cu of ewes giving birth to Swayback lambs.*

The blood Cu of ewes giving birth to Swayback lambs showed no significant differences compared with that of the ewes in the same group giving birth to normal lambs.

TABLE IV.

Blood Cu of Ewes on Experiment. Mg./100 c.c. whole blood.

		Controls Group A			Controls Group B		
		Nov.	Jan.	April	Nov.	Jan.	April
Unaffected ewes.	Mean ...	0.030(23)	0.064	0.070	0.032(28)	0.034	0.071
	S.D. ...	±0.018	±0.018	±0.021	±0.019	±0.023	±0.023
Affected ewes.	Mean ...	0.033(15)	0.058	0.066	0.023(10)	0.023	0.074
	S.D. ...	±0.020	±0.018	±0.035	±0.013	±0.009	±0.026

Date drafted		Group D 0.3% Cu licks			Group C 1% Cu licks		
23.12.38							
Unaffected ewes.	Mean ...	0.033(28)	0.031	0.082	0.036(14)	0.062	0.106
	S.D. ...	±0.018	±0.021	±0.023	±0.018	±0.021	±0.014
11.1.39							
Unaffected ewes.	Mean ...	0.042(10)	0.042	0.095	0.037(10)	0.045	0.096
	S.D. ...	±0.026	±0.014	±0.039	±0.019	±0.015	±0.027
1.2.39							
Unaffected ewes.	Mean ...	0.042(12)	—	0.079	0.036(11)	—	0.096
	S.D. ...	±0.023	—	±0.019	±0.024	—	±0.038
Affected ewes.	Mean ...	0.028(3)	—	0.077	0.011(1)	—	0.059
	S.D. ...	±0.020	—	±0.017	—	—	—
23.2.39							
Unaffected ewes.	Mean ...	0.038(12)	—	0.082	0.034(10)	—	0.105
	S.D. ...	±0.019	—	±0.021	±0.030	—	±0.023
Affected ewes.	Mean ...	0.038(6)	—	0.086	0.027(1)	—	0.092
	S.D. ...	±0.025	—	±0.016	—	—	—

(d) *The Cu reserves of Swayback and Unaffected lambs and ewes.*

A comparison of the Cu reserves of unaffected and swayback lambs is given in Table III. The Cu reserves in the liver of unaffected lambs appears to be somewhat higher than those of affected animals, but the amount of Cu in the liver of both unaffected and swayback lambs in this particular area is very much lower than commonly accepted standards for the sheep (Cunningham, 1931). The blood Cu of unaffected lambs is, on the other hand, significantly higher than that of swayback lambs, but the levels are not so far removed from normal standards as is the level of Cu in the liver. No differences were found between the concentration of Cu in the brains of unaffected and swayback lambs. From the few analyses made of the Cu reserves of the ewes on experiment, it would appear that the level is similarly low compared with normal standards, but that, again, there is no difference between animals giving birth to unaffected or affected lambs.

Moore (1938), working in Australia on coast disease in sheep, which is due to a deficient intake of Co combined with Cu, found a very low Cu content of the liver of adult animals similar to that which we had found among sheep and lambs in Derbyshire, but Moore found that this low reserve of Cu in the liver was not accompanied by a low blood Cu. Schultze, Elvehjem and Hart (1936) found that when pigs, rendered anæmic by a milk diet, were fed iron and copper the blood Cu rose, but the storage of Cu in the organs was not raised to the same extent compared with untreated controls. Therefore, from the results of feeding Cu to animals suffering from a disease associated with a diminished Cu intake, it appears that the blood Cu is maintained at the expense of the liver Cu.

Discussion

The chemical work was an obvious necessity if any answer was to be forthcoming regarding why copper acts in such a remarkable prophylactic manner against the disease. The enormous amount of chemical work which was done has furnished much valuable information regarding the distribution of copper in the tissues of Derbyshire sheep. Nevertheless, it must be admitted that we still do not know (a) whether swayback is really due to Cu deficiency of the ewe in the true sense of the term, (b) why the disturbance in the metabolism of Cu in the pregnant ewe affects only the myelin of the developing lamb, and (c) why Cu supplements to the pregnant ewe should result in the normal process of fœtal cerebral myelination. Indeed, the part played by general metabolism in the normal process of myelination is so obscure that a full explanation of the pathogenesis will only be achieved by a biochemical approach to the problem from many different angles. That this might have a fundamental bearing on the demyelination problem in general requires no emphasis.

At the moment we must try to determine the significance of the chemical results at our disposal. That swayback is not a Cu deficiency of the pregnant ewe *per se* has already been indicated in a previous paper by ourselves. The validity of this statement lies in the fact that in this Derbyshire area and in others, chemical analyses showed that the Cu content in the grass was not below that of grass from normal areas. Why, therefore, the addition of Cu in the form of $CuSO_4$ should prevent the disease is inexplicable unless it is a matter of availability. This question of availability, in fact, seems to be the only possible explanation. Many samples of grass from North Derbyshire were shown previously to contain a high Ca/P ratio. Such a diet has been shown by Anderson, McDonough and Elvehjem (1940) in the case of rats to result in decreased utilisation of Fe and probably also of Cu. There is also the possibility, of course, that the unusually large amount of lead and zinc in the grass may interfere with the normal absorption of Cu from the alimentary tract.

The blood Cu of all ewes on experiment increased with the advance of pregnancy, which seems to indicate that this is a normal physiological event comparable to that found by Tompsett (1935) in pregnant women. Work which has subsequently been carried out in ewes in Cambridge has not confirmed this rise in blood Cu throughout pregnancy, so it may be that this "physiological rise" in blood Cu during pregnancy in sheep may only occur when the initial level of blood Cu is too low to satisfy the demands of the fœtus. The rise in blood Cu in the ewes in Derbyshire was, however, more pronounced in the ewes receiving supplementary Cu, except in those of the two small sub-groups of Group D, which had received the licks for only four and seven weeks before parturition, in which there was no difference compared with the animals in the control Groups A and B. It was in these same sub-groups of Group D in which the incidence of Swayback (of all the Cu treated groups) was most marked, and in the sub-group which was given the Cu licks for only four weeks before parturition, the incidence of swayback was similar to that in control Group B (Table I). In the other sub-groups of C and D the ultimate level of the blood Cu (in April) after lambing was similar and was not related to the length of time during which the Cu supplements had been fed. It can therefore be concluded that the addition of small amounts of Cu to the diet does increase the blood Cu level of these ewes in Derbyshire and hastens the physiological rise during pregnancy. While this appears to coincide with the prevention of swayback in the progeny, there is no constant relationship between the ultimate level of blood Cu in the ewe and the occurrence of the disease in the lamb. In the control Groups A and B, and in the latter two sub-groups of Group D, there were many ewes which gave birth to swayback lambs which had a higher blood Cu than those giving birth to normal lambs. This may appear anomalous, but simply indicates that the blood Cu is not the primary factor in the ewe which initiates the disease

in the fœtus. It is thus not possible to define the limit of Cu in the blood of the ewe below which the progeny will develop swayback.

The first two sub-groups of Group C did not have a markedly higher blood Cu in April than the other two sub-groups where only two affected lambs were born. The relation between the length of time of feeding Cu to the ewe and the development of swayback in the progeny might indicate that the fœtal requirements are optimal for normal development about mid-term. In relationship to this, the work of Wilkerson (1934) may be relevant. In following changes in the storage of Cu in developing pig embryos, he found a constant increase up to the 20 mm. stage which was then followed by a steady decrease. This decrease was, however, relative rather than absolute and was considered to be due to the rapid influx of organic and inorganic matter which occurred about the 30 mm. stage. In 10-20 mm. embryos the liver represented about 14 per cent. of the body weight, but this decreased to about 4 per cent. in embryos of 160 mm. In any consideration of the fœtal requirements of the lamb for Cu it is as well to remember the enormously greater rate of intra-uterine growth combined with a short gestation period compared, for example, with the human being. The lamb is born at a stage of development (e.g., ossification and cerebral myelination) which is not reached in the human being until the individual attains an age probably of seven years (Harris, 1939).

The storage of Cu in the liver of ewes and lambs in Derbyshire is similar to that found by Bennetts and Chapman (1937) in Australia, although the levels found by them in the blood of ewes are much lower than our figures. Their results have been discussed previously (Innes and Shearer, 1940), but it must be emphasised that somewhat higher levels of Cu in the liver and the blood have been found by us in unaffected than in affected lambs. The ewe which gives birth to an unaffected lamb *must*, therefore, have more Cu *capable of being transferred* to the fœtus than the ewe giving birth to an affected lamb. We are thus faced with a puzzling feature that in many cases no differences in the Cu content are found in the blood of such ewes compared with the normals. This transference of the Cu from mother to fœtus may ultimately be found to be an important feature and may be explained along the lines of the work of Mann and Keilin (1939). They showed that the Cu in the blood is not present in the inorganic state but as a Cu-protein complex—hæmocuprein, and that the liver contains a different complex—hepatocuprein. It might be deduced from this that when the Cu is absorbed by the ewe it is transferred to the liver and converted into hepatocuprein where it is changed into hæmocuprein for liberation into the blood stream. Hepatocuprein, however, is probably not the only Cu-protein complex which occurs in liver (Mann, 1940), and it may be that the level of hepatocuprein or the other Cu complexes in liver may govern the transference of Cu from mother to fœtus.

To what extent can we now trace the pathogenesis of the disease? Adequate copper is available in the pasture and is ingested, but some factor

interferes with its proper assimilation. That this conditioned deficiency takes some time to develop is evident from the fact that ewes are more prone to give birth to swayback lambs when they are pastured on "affected" land for more than one lambing season. This factor must in some way be bound up with the areas or pastures involved because transference of ewes, during pregnancy, to other "clean" areas somehow prevents the disease. The interference of the assimilation of Cu by the ewe is not reflected by the lowering of the Cu reserves in the liver or in the blood to an extent which causes any recognisable pathogenic effect in the ewe. Although it has been shown in other animals that Cu deficiency does interfere with normal hæmatopoiesis, this is not the case in the ewe. The main effect would appear to be then simply that of the capability of transference of Cu from mother to the developing fœtus which appears to be a fundamental necessity for correct myelin formation. The manifestation of this is in the fœtus results in the development of a disease first observed when the animal is born. The chemical results suggest that the demands of the fœtus are optimal about, or shortly after, mid-term, and previously on pathological grounds we contended that the disease process in the fœtus is initiated about the 15-16th week. This corresponds to the stage when cerebral myelination begins to become active. At present no further explanation is possible. The problem has not been solved by the discovery of a successful form of preventive treatment.

There is no indication at present that a similar mechanism is involved in any of the demyelination diseases in man, although the possibility of any of these being due to a trace element deficiency has never been investigated.

Summary

The low level of Cu in the blood and liver of lambs suffering from swayback disease has been confirmed. Affected lambs have a lower blood Cu and liver Cu than unaffected lambs. The blood Cu of unaffected and affected lambs is, however, not so far removed from the normal as is the liver Cu which is found to be about one-tenth of the normal standards.

While there appears to be no direct relationship between the blood Cu of the ewe and the development of swayback in the progeny, nevertheless, it appears that the demands of the fœtus for Cu must be satisfied about half-way through pregnancy.

Lead appears to play no major role in the etiology of the disease. No difference was found in the lead content of tissues from affected and unaffected lambs or adults. From the amounts of lead found stored in the tissues of adult sheep it appears that the sheep is very resistant to lead poisoning.

The apparent resistance of the sheep in this area to a toxic intake of lead is discussed as is the reason for the Cu deficiency on an adequate Cu intake.

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Acknowledgments

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ANTHRAX IN HORSES

By ZAKI MORCOS, F.R.C.V.S., M.V.Sc., D.V.H. (Eng.)

Cairo Veterinary School, 1940.

RECENTLY there has come to my notice a series of cases of illness in horses in which the symptoms resembled those generally ascribed to infection with B. anthracis. In none of the cases seen alive was the organism recovered but in most of those treated with anti-anthrax serum, recovery took place. No evidence was found of any source of infection.

There are several references in the literature concerning some of the findings in the cases with which I dealt.

Hutyra, Marek and Manninger (1938) discuss the harbouring of spores by horses and the effect of influences such as cold, heat, over-exertion, intercurrent infection as likely causes of an acute attack of the disease in such spore carriers. They also draw attention to the similarity of symptoms of acute anthrax infection and intestinal obstruction or invagination. Wooldridge (1934) refers to the symptoms of colic, the swelling of the throat and the

difficulty in breathing. He notes that it may be necessary to examine the pharyngeal, lymphatic or mesenteric glands to obtain a diagnosis. Eurich and Hewlett (1930) describe two forms of anthrax infection in the horse—an acute, septicæmic type in which death usually occurs in 8 to 30 hours in which there are no external lesions, and a milder form characterised by swellings in the region of the head, neck and shoulder. Kendall (1929) refers to infection through the skin. Muir and Ritchie (1927) point out the relative non-susceptibility of the horse and draw attention to the acute type of disease in which death occurs in 12 to 48 hours and the occurrence of blood-stained discharges from the natural orifices. Bigger (1932) states that the blood appears to possess higher powers of resistance than that of other body tissues and that it is only when the animal's resistance is completely broken down that a true septicæmia occurs. Gaiger and Davies (1932) refer to the apparent absence of bacilli from the blood and the severe colic which accompanies the infection. Rice (1938) comments on the intestinal irritation with the presence of blood in the fæces which contain the bacilli. Mackie and McCartney (1934) state that the bacilli might not be detectable in the blood of infected horses. Scott (1913) comments on the tendency of the infection to localise in the throat glands and the fatal character of the disease when the intestine or lungs become involved. Drimmelen (1938) reports the absence of bacilli in the blood in one of three infected cattle. Topley and Wilson (1936) quoting Stockman (1911) refer to the fact that infected horses may die before bacilli have proliferated sufficiently to be detected in the blood. Lutje (1936) discusses the essentially localised character of the infection. Weidlich (1934) reports the treatment of an infected cow with antiserum. The animal recovered from the acute disease but the bacilli became localised in the udder. Kmosko (1934) considers that the most important factors predisposing to anthrax are the presence of virulent bacilli in the digestive organs, especially the large intestine and lesions in the digestive tract caused by coarse forage plants.

Cases

1. Dark bay Arab pony, 4 years old, at racing stable in Heliopolis. When first examined the pony was down and was passing watery, greenish, offensive-smelling fæces without presence of blood. The mucous membrane of the eyes and gums was deeply congested and spasmodic colic was observed. Breathing was laboured and attempts to rise were unsuccessful. The temperature was 39 deg. C.

A pony had died in the same stable about a month previously after showing similar symptoms for about 48 hours and at the post-mortem examination (carried out by a veterinary surgeon) the blood was found dark and not quite coagulated. There was also an inflammation of the internal organs, including the intestine. The term " hæmorrhagic gastro-enteritis " was used.

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Anti-anthrax serum (50 c.c.) was injected intramuscularly at 7 p.m. Next day at 6 a.m. the pony was on his feet and was attempting to eat green food. A further 50 c.c. serum was injected. Complete recovery took place and the pony won several races a month later. Blood (15 c.c.) drawn before the first dose of serum yielded negative cultures, and emulsions of food and water injected into guinea-pigs failed to set up infection.

2. Grey Arab pony, 3 years old, in the same stable. When seen the pony was standing but was showing symptoms of violent colic and was passing watery, very offensive-smelling fæces with no evidence of blood. The temperature was 38.8 deg. C. Breathing was difficult and the mucous membranes of the lips, gums and eyes were deeply congested. Anti-anthrax serum (100 c.c.) was injected intramuscularly. Recovery was complete and the pony won races 40 days later. Blood (30 c.c.) drawn before the serum was injected remained sterile when examined culturally.

3. Grey Arab pony, 3 years old, in the same stable. Illness reported three weeks later. Symptoms similar. Anti-anthrax serum (40 c.c.) injected intramuscularly. The pony recovered. Blood cultures were sterile.

In connection with the above cases it was found that in all the horses in the stable the tendons of the fore legs were covered with mud of an astringent nature. Guinea-pigs inoculated with this material remained healthy.

As a prophylactic measure the remaining 25 horses in the stable were injected intramuscularly with anti-anthrax serum (30 c.c.). No illness of a similar character developed (up to January, 1940).

4. Dark bay thoroughbred mare, 4 years old, in a neighbouring stable. Diarrhœa developed but no colic. The mucous membranes appeared normal. Astringent sedative treatment was prescribed. Owing to illness the case was taken over by another veterinary surgeon. The mare died in five days. No infectious disease was found.

No further cases occurred in this stable.

5. Dark bay mare, pregnant, at Adda's farm, near Alexandria. The mare became ill on July 12, 1939. She was in rather poor condition, the temperature was 38.9 deg. C. and she was breathing with much difficulty and was snoring so loudly that the noise could be heard many yards away. There was a profuse nasal discharge and salivation was marked. The mare was on her feet. Crepitation of the lungs was very distinct and the pulse was fading and scarcely perceptible. No symptoms of colic were observed in this case. The mare aborted and died the same night. No serum was given. Blood films were negative. Post-mortem examination showed pleuro-pneumonia and peritonitis. There was no history of similar disease on the farm.

6. Grey Arab mare on the same farm in box next to Case 5. Illness was observed on July 13, 1939, when symptoms of severe colic were evident. There was an offensive smelling diarrhœa without blood but the gums and eyes were not deeply congested. Anti-anthrax serum (20 c.c.) was injected. The

violent colic subsided within an hour but symptoms returned later in the evening. No more serum was available. The mare died in a state of coma next day. Blood examined by film and culture showed no bacilli. The Municipal authorities also examined blood by culture and animal inoculation but failed to find B. anthracis. Food and water were also examined with negative results.

7. Bay thoroughbred mare, on the same farm. The mare became ill 16 days after case 6. There was evidence of severe spasmodic colic which was treated by the veterinary surgeon in charge of the case. By next day the mare was in a very distressed condition, showing symptoms of severe pain and asphyxia. She died the same day. Blood was negative to anthrax. Because of a history relating to a stray dog, the brain was examined at the Anti-rabies Institute in Cario, but no evidence of rabies was found.

8. Mule. The spleen only was available. The animal had died suddenly and no bacilli were found in the blood. Section of the spleen revealed organisms indistinguishable from B. anthracis.

9. Black Arab pony, 4 years old. At 3 p.m. on January 3, 1940, was found showing symptoms of discomfort resembling spasmodic colic. The mucous membranes of the lips and eyes were congested. The temperature was normal. Abdominal massage was applied and a soapy enema (6 litres) was administered. At 10 p.m. symptoms of spasmodic colic were marked and further treatment was carried out. The symptoms, however, became more marked. At 7 p.m. next day anti-anthrax serum (30 c.c.) was injected intramuscularly. Within 40 minutes the colic was relieved and the pony was in normal health the next day.

Discussion

The points of interest in these cases are the similarity of the chief symptoms, the response to the injection of anti-anthrax serum, and the uniform absence of B. anthracis in the blood. It is unfortunate that further examination of the subjects was not possible. That the disease from which the affected animals suffered bore a striking resemblance to anthrax is borne out by a consideration of the literature cited above. The persistent spasmodic colic, the congested state of the mucous membranes of the eyes and mouth and the difficult breathing, dyspnœic in character, are all quoted by observers as being clinical symptoms of anthrax in the horse. The fact that the animals treated with anti-anthrax serum recovered while the untreated animals, which showed similar symptoms, died, adds to the possibility of anthrax infection.

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AN OBSERVATION ON THE HABITS OF DOMESTIC CATTLE

By A. BROWNLEE, B.Sc., M.R.C.V.S.

THE subjects of observation were seven in-calf cows at pasture and the observations were made on May 8, 1938.

10.30 a.m.—All the animals were lying.

10.56 a.m.—No. 1 animal, after lying on its right side, rose up and commenced grazing and at 11 a.m. lay down again, this time on its left side.

11.14 a.m.—No. 2 rose up from right side and soon lay down again, this time on left side.

11.31 a.m.—No. 3 rose up from left side and soon lay down again, this time on right side.

11.31 a.m.—No. 4 rose up from right side, commenced grazing and at 11.36 a.m. lay down, this time on left side.

11.34 a.m.—No. 5 rose up from left side, commenced grazing and at 11.35 a.m. lay down again, this time on right side.

11.52 a.m.—No. 6 rose up from right side, commenced grazing and at 11.55 a.m. lay down again, this time on left side.

12.17 p.m.—No. 7 rose up from right side and soon lay down again, this time on left side.

12.34 p.m.—No. 1 again rose and soon lay down again, this time on right side.

Observations were then discontinued.

Note.—Housed cattle have also been observed to change the side on which they were lying.

STUDIES ON ORGANISMS OF THE GENUS LISTERELLA

IV—An Outbreak of Abortion Associated with the Recovery of Listerella from the Aborted Fœtuses

By J. STUART PATERSON

Institute of Animal Pathology, University of Cambridge.

Introduction

ABORTION in sheep, whilst not uncommon, is not of great economic importance. It is generally only when outbreaks are severe that the attention of veterinarians is drawn to them.

In this country, epizootic abortion in sheep has been shown to be due to two specific micro-organisms, viz., *Vibrio fetus* by McFadyean and Stockman (1913), and *Salmonella abortus ovis* by Bosworth and Glover (1925). Elsewhere, *Brucella abortus* (Bruce, 1930), *Brucella melitinsis* (Itabashi *et al.*, 1937) and *Bact. coli*-like organisms (Howarth, 1932, and Lee and Scrivner, 1938) have also been incriminated.

Occasionally, one meets with outbreaks in this country in which laboratory examination fails to reveal the presence of either *V. fetus* or of *S. abortus ovis*, and the outbreak is regarded as due to some non-specific cause such as mismanagement or change of diet.

It is interesting to note that recently in the U.S.A., Graham, Hester and Levine (1939, 1940) have recorded the isolation of a typical *Listerella* from a premature bovine fœtus originating in a Bang's disease-free herd. They were able to induce an artificial abortion in a pregnant heifer by intravenous inoculation of the organism.

The isolation of *Listerella* from three out of four premature fœtuses in a small flock of sheep in Northamptonshire together with the observations of Graham *et al.*, suggested the possibility of *Listerella* being an ætiological agent of some importance in abortion of ruminants. The flock history, together with a description of the organism isolated, is given below. The experimental reproduction of abortion in sheep is also dealt with in this article.

History of the Outbreak

The flock comprised a total of 92 Dorset Horn ewes and 18 Cross-bred ewes, of which 32 were shearlings. The abortions were confined to the shearlings, which had been pastured apart from the ewes from March to August, 1938. The entire flock was run together for mating purposes during

September and October, after which the shearlings were separated from the older ewes and pastured by themselves. The general management of the flock was good. There was no previous history of ovine abortion on the premises. Lambing was due to commence on January 28, 1939.

Abortions commenced on December 10, 1938, but were thought to have been due to disturbance of the shearlings by the passage of the local Hunt. Abortions continued irregularly, and the last occurred on February 10. In all, 16 of the shearlings aborted or gave birth to dead lambs. Four single lambs born alive before January 28 were successfully reared.

Three fœtuses were examined at Reading University. From the fourth stomach of each of two fœtuses aborted on January 12 small gram-positive, cocco-bacilli were recovered, but cultures from the third, aborted on January 20, remained sterile. A fourth fœtus, aborted on January 23, was received for routine examination at this Institute. A gram-positive bacillus (referred to below as the Moulton strain) was isolated from the fourth stomach. The organisms were found to be identical in every respect with those isolated at Reading. No macroscopic abnormalities were detected in any of the fœtuses.

Field Investigations

By the time the author had been put in touch with the outbreak abortions had ceased. Swabs were taken (14.2.39) from the cervices of the six ewes which had most recently aborted. They all proved negative for *Listerella.* The sera of four ewes which had aborted, four ewes on contact with those which had aborted (two lambed and two unlambed) and two ewes (one lambed and one unlambed) from the main (unaffected) flock, proved negative for agglutinins when tested against both "H" and "O" suspensions of the Moulton strain and when tested against similar suspensions of a typical member of the genus *Listerella.*

The 16 ewes which had been aborted were slaughtered on March 3, 1939. No abnormalities were detected in the organs or viscera. All the uteri appeared to have undergone normal involution. Culture media were inoculated with the fluid aspirated from the uteri by Pasteur pipette. The uteri were then opened with aseptic precautions and media were inoculated with scrapings from the internal surface. Cultures were made on blood agar plates, serum agar slopes and into serum broth in each instance. In no cases were *Listerella* recovered. The internal surface of all the uteri appeared to be normal.

Description of the Organism Isolated

The Moulton strain, together with the Reading strains, were examined by the writer. Although not conforming in every respect to the accepted characters for *L. monocytogenes* (Murray *et al.*, 1926) the organisms were considered

to belong to the genus *Listerella*. They conformed to the type species in so far as they were motile, non-sporing, hæmolytic gram-positive cocco-bacilli. On blood agar plates there was produced a wide zone of true beta hæmolysis which extended far beyond the edge of the colony. This is an unusual feature since with most strains the zone of hæmolysis rarely extends more than 0.5 mm. beyond the edge of the colony. Their biochemical activities, except that xylose was strongly fermented and that rhamnose was not, were in agreement with those of the *Listerella*. Serologically, their flagellar antigenic structure was identical with group A *Listerella* (Paterson, 1939), but it was not possible with the freshly isolated strains to investigate their O antigenic structure since rabbits did not produce O agglutinins, nor were O suspensions agglutinated by high titre *Listerella* O antisera.

Further confirmation that Moulton belonged to the *Listerella* group lay in the fact that when lethal doses were injected into rabbits and mice, necrosis of the liver and spleen was produced. Further, the organism stimulated a circulating monocytosis in rabbits when sublethal doses were inoculated intravenously.

After six months' maintenance on artificial media it was noted that the zone of hæmolysis on blood agar plates was markedly reduced and, by the ninth month, the hæmolytic activity was normal. Fresh suspensions were prepared and it was found that they stimulated the slight production of O agglutinins when injected into rabbits. Likewise, these suspensions were slightly agglutinated by O antisera prepared with other strains of *Listerella*. The strain still fermented xylose strongly and failed to ferment rhamnose.

Attempted Reproduction of Abortion in Pregnant Sheep with Pure Culture

In order to test the abortifacient properties of the strains of *Listerella* which had been isolated by the writer (Moulton) and by Graham *et al.* (1939, 1940), (strain No. 27681), pregnant sheep were inoculated intravenously and others were given large doses of culture by mouth. Parallel experiments were carried out in which an avian strain (LS/2), Paterson (1937), was used.

(i) Intravenous inoculation:

Two pregnant sheep were inoculated with 2 ml. serum broth culture of each strain. The immediate effects were a marked rise in the body temperature and a diminution in the appetite. By the 96th hour after injection the animals appeared completely normal. With one exception the animals continued to appear normal and their temperatures remained within the normal range. The exception was one of the sheep inoculated with Graham's strain No. 27681 which showed symptoms of an encephalitis on the fourth day. She was completely paralysed on the following day, but on the sixth day a marked improvement in her condition was noted. All the ewes expelled their fœtuses

between the seventh and twelfth days after inoculation. Some of the sheep were almost full-term, whereas others were not more than 2½ months pregnant. With one exception, the fœtuses showed some slight degree of putrefaction, indicating that they had been dead for some time before being expelled. Post-mortem examination revealed a focal necrosis of the liver, a turbidity of the cerebro-spinal fluid and an œdema of the meninges which were congested. Profuse pure cultures of *Listerella* were obtained from all parts of the body including the central nervous system. The exception was that full-term twins from one of the sheep inoculated with the Moulton strain were born alive and died within a few moments. Both these lambs showed a marked keratitis in addition to liver necrosis, and in these cases the organisms were recovered from the organs but not from the central nervous system.

Histological examination of liver and brain sections from the affected fœtuses showed that in the liver there were evenly distributed foci of hepatic necrosis infiltrated with polymorphonuclear and mononuclear leucocytes (Fig. 1). The meninges, especially in the area adjacent to the base of the brain, showed an acute purulent meningitis and small foci of necrosis of the brain tissue, particularly in the midbrain and medulla. The lesions were in accordance with the distribution of the bacteria.

One of each pair of ewes was killed immediately after abortion had occurred, and the other 21 days later. The five ewes which had remained apparently normal throughout the experiment did not show any pathogenic abnormalities. *Listerella* were recovered from the uteri of the sheep slaughtered immediately after aborting, but similar cultures made from those slaughtered after 21 days' interval were sterile. Cultures from the liver, spleen, mammary gland and heart blood were sterile. However, pure cultures of *Listerella* were recovered from the mammary glands, cerebro-spinal fluid, spinal cord and cerebrum of the ewe which had shown encephalitic symptoms, but heart blood and liver cultures remained sterile.

Histological examinations of sections of the uteri of the ewes killed immediately after abortion showed that an intense inflammatory reaction was taking place at the junction of the maternal and fœtal cotyledons. Large masses of bacteria were seen actively multiplying at this point and invading the fœtal part of the cotyledon. Examination of sections of uteri of the sheep which were kept for three weeks after abortion showed that involution was proceeding normally; that the uterine mucosa had in most cases completely grown over the cotyledons and that bacteria were still readily visible in the sub-mucosal layers in small numbers. The ewe which had shown encephalitis was one of those slaughtered immediately after abortion, and in addition to the gross reaction in the uterus, there was a definite meningitis, areas of softening in the brain, particularly beneath the fourth ventricle, and a marked cuffing of the blood vessels.

The experiment reported by Graham *et al.* (1940), in which a pregnant

heifer aborted following the intravenous infection of a suspension of strain 27681, has been repeated by the author on a pregnant cow. She was inoculated intravenously with 5.0 ml. of an 18-hour serum broth culture. There was a transient rise in body temperature and a diminution of the appetite. The cow aborted its fœtus on the tenth day after inoculation. Unfortunately the cow ate the fœtus and the fœtal membranes and therefore no examination could be made. The cow was slaughtered immediately after it had aborted, and *Listerella* were recovered in pure culture from the uterus. Histological examination of the uterus showed that the reaction in the cotyledons and the distribution of the bacteria were identical with those observed in the experimental sheep.

(ii) ORAL ADMINISTRATION:

Three heavily pregnant sheep were dosed three times weekly with the equivalent of 500 ml. of an 18-hour serum broth culture of strains LS/2, Moulton and 27681.

The sheep dosed with LS/2 received 14 doses before it gave birth to normal twin lambs; the sheep dosed with Moulton received three doses before it gave birth to normal twin lambs, and the third sheep dosed with 27681 received 18 doses before it gave birth to a single normal lamb.

No untoward symptoms were noted in the ewes throughout the experiment. The ewes, which were all in good bodily condition, and their lambs were destroyed as soon as practicable after the lambs were born. All were subjected to a careful pathological, bacteriological and histological examination, but the results were entirely negative. No lesions were noted and no bacteria were recovered.

Discussion

The possible role of *Listerella* as an ætiological agent of abortion in ruminants is suggested by the statements of Graham *et al.* (1940) and by the observations recorded in this paper.

Burn (1936) has described four cases of human infection, two of which concerned infants which lived for less than 36 hours. The first case concerned a newly born infant which was three weeks premature. The mother, who was a 27-year-old multipara, had had a spontaneous abortion between her first and third pregnancies. She had three children alive and well. The infant died 36 hours after birth. Blood cultures were positive for *Listerella.* Post-mortem examination revealed focal necrosis of the liver, focal pneumonia and a certain amount of hæmorrhage into the ventricles of the brain. The second case concerned a normal full-time infant which died 24 hours after birth. The pathological features of this case were similar to the first case described. In the latter case, vaginal swabs of the mother eight days after

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parturition failed to reveal any abnormal bacteria, nor could agglutinins for the organism isolated from the infant be demonstrated in the sera of either its father or mother.

There are certain similarities between Burn's observations and the results obtained by the writer with experimentally infected sheep:

(a) where the sheep fœtuses were sufficiently developed they were born alive, but, like the human cases, they died soon after birth;

(b) the organisms were widely distributed in the tissues including the central nervous system;

(c) the marked necrosis of the liver; and

(d) the clinical and bacteriological examination of the mothers some time after abortion were negative.

The possibility of the human cases having been due to intra-uterine infection must be borne in mind as a theoretical possibility.

Summary

1. An outbreak of abortion in sheep is described in which *Listerella* were recovered from the fourth stomachs of aborted fœtuses. No trace of infection was determined in the ewes.

2. The intravenous injection of *Listerella* into pregnant sheep is followed by the localisation of the bacteria in the uterus, fœtal membranes and fœtus, finally causing expulsion of the fœtus.

3. The oral administration of cultures to similar sheep failed to provoke abortion.

4. The possibility of certain cases of listerellosis of human infants being due to intra-uterine infection is discussed.

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FIG. 1.—Head of Foal—Case of Cyclopia.

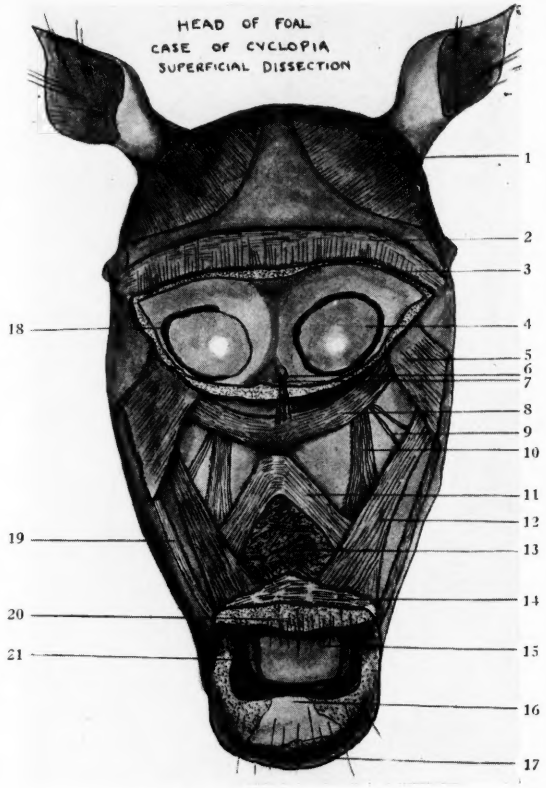

FIG. 2.—Head of Foal—Case of Cyclopia.

SUPERFICIAL DISSECTION

1. M. Parieto-Auricularis.
2. M. Orbicularis Palpebrarum.
3. Eyelid.
4. Cornea of Left Eyeball.
5. Inferior Palpebral Muscle.
6. Caruncula of Left Eyeball.
7. Punctum of Left Eyeball.
8. M. Levator Labii Superioris Proprius.
9 & 10. Branches of Infra-orbital Nerve.
11. Levator Labii Superioris Alaeque Nasæ.
12. M. Dilatator Naris Lateralis.
13. Mixed fibro-fatty tissue and intercrossed bundles of Dilators of Nostrils.
14. M. Orbicularis Oris.
15. Tongue.
16. Lower Lip.
17. Chin.
18. Incomplete Choroid of Left Eyeball.
19. M. Zygomaticus.
20. Upper Lip.
21. Gum covering Incisor Teeth.

Clinical Articles

A CASE OF CYCLOPIA IN THE FOAL

By H. V. HUGHES, B.V.Sc., M.R.C.V.S., D.V.H.

and

J. W. DRANSFIELD, B.V.Sc., M.R.C.V.S.

Department of Veterinary Anatomy, The University of Liverpool.

THE purpose of this article is to give an account of the peculiarities of structure of the head of a bay Shire foal, showing cyclopia, which was kindly sent to the Department by Mr. E. Greenway, M.R.C.V.S., of Frodsham. The foal was born alive at full term and had evidently lived for a short time after birth, since grass was found in the mouth. Only the head was sent to us, but we were assured that the remainder of the body was normal.

Two eyes were present, but they had become closely approximated and were accommodated in a single orbit which lay in front of a very dome-shaped cranium (Fig. 1). The upper and lower eyelids of each eye were continuous with one another across the middle line and there was a single conjunctival sac. No membranæ nictitantes were apparent, but in the lower eyelid near the centre lay the caruncula and lower punctum lachrymalium of the left eye. The face was short and flattened from above to below in front of the orbit. There was no suggestion of a proboscis above the orbit, which is such a common feature in cases of cyclopia, nor was there any trace of nostrils, but a group of tactile hairs appeared in the position where the nostrils might be expected. The upper lip was about two inches shorter than the lower and as a result the tongue protruded from the mouth.

Dissection revealed the fact that there was considerable deviation from the normal towards the middle line of the face resulting from the suppression of all the structures in the middle line including the nose (Fig. 2). Behind the upper lip lay a mass of fibro-fatty tissue interspersed with muscle fibres, which latter represented the vestiges of the muscles lying in the region of the anterior nares. The levator labii superioris proprius suffered as a result of the suppression of the nostrils, since it joined its fellow of the opposite side in the mid-line just behind the mass of fibro-fatty tissue already mentioned, and the common tendon could not be traced to its normal insertion in the upper lip. The other muscles of the lips were all apparent, although the origin of the levator labii superioris alæque nasi was indistinct, and was

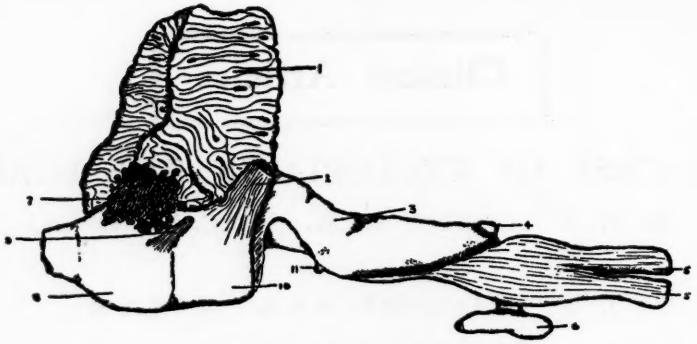

FIG. 3.—Brain of Foal—Case of Cyclopia.

LATERAL VIEW

1. Cerebellum.
2. 5th Cranial Nerve.
3. Corpora Quadrigemina.
4. Fornix.
5. Optic Nerves passing from Optic Thalami.
6. Pituitary Body.
7. Choroid Plexus of 4th Ventricle.
8. Medulla.
9. 7th Nerve.
10. Pons Varolii.
11. Corpus Albicans.

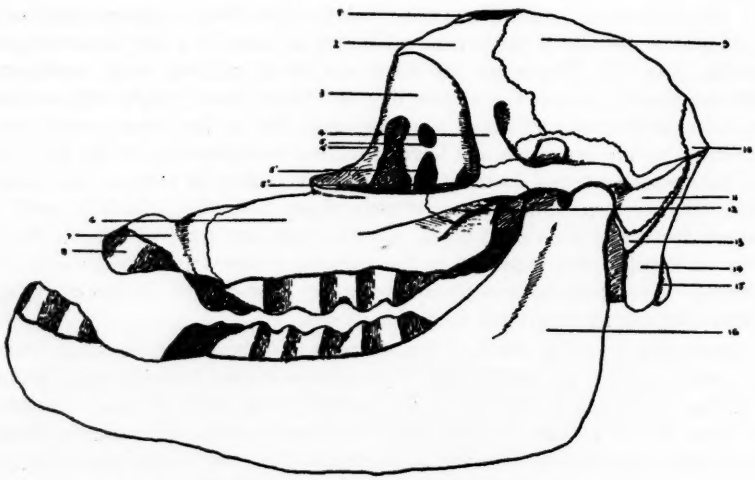

FIG. 4.—Skull of Foal—Case of Cyclopia.

ANTERO-LATERAL VIEW

1. Fontanelle.
2. Frontal bone.
3. Orbital Plate of Frontal forming Wall of Orbit.
4-4′. Supraorbital processes.
5-5′-5″. 3 Foramina in Orbit.
6. Superior Maxilla.
7. Premaxilla.
8. Teeth in Premaxilla.
9. Parietal Bone.
10. Occipital Bone.
11. Squamous Temporal Bone.
12. Malar.
13. Mastoid process of Petrous Temporal.
14. Styloid Process of Occipital.
15. Occipital Condyle.
16. Inferior Maxilla.

blended with its fellow of the opposite side. The nasal cavity was represented only by a blind pouch extending for a distance of about one inch upwards and forwards from the pharynx between the soft palate and the sphenoid bones. The cavity of the mouth showed beneath the upper lip a knob-like protuberance in which the two central incisor teeth lay overlapping one another. Behind this the hard palate was deeply depressed along the middle line. Two molar teeth had erupted on each side in the upper jaw and three on each side in the lower jaw.

The single orbit lay across the front of the cranium, and its posterior wall, formed largely by the orbital plates of the frontal bones, showed two large foramina, one on either side, each ¾ inch in diameter (Fig. 4). These foramina represented the combined foramina of the orbital hiatus with the exception of the foramen rotundum which was quite distinct and lay below. Above the foramen of the right side lay another large opening, through which a hernia of the superior oblique muscle of the right eyeball projected into the cranial cavity. The orbit contained two distinct eyeballs enclosed in a common periorbita and connected by a common conjunctiva. The left eyeball was rather larger than the right. The superior, external and internal recti muscles of each eyeball were normal. The inferior recti were situated towards the inner side of the eyeball, and each gave off a bundle running to join a mass of intercrossed fasciculi representing the inferior oblique muscles. Each superior oblique muscle consisted of two divisions—lateral and medial. The lateral bundle ran through the usual fibrous pulley, lying on the roof of the orbit, to its normal insertion; the medial division joined its fellow in the mid-line and from the junction fibres passed forwards to form a fasciculus accompanying the lateral division to its insertion. It will be seen from the above description that, in addition to the orbits being joined by a common conjunctiva, they were also bound together by the intercrossed fibres of the oblique muscles. The retractor oculi was most prominently developed supero-externally and infero-internally. The nerves and vessels of the region appeared generally normal except towards the middle line where they could not be traced. The eyeballs themselves were more conical than globular, the apex of the cone lying at the optic nerve. The lachrymal glands were large and lay in the usual position.

The cranial cavity was very much increased in size, particularly in the region of the frontal and parietal bones. A large fontanelle occurred on the right side of the mesial suture between these bones. The corresponding area on the left side was occupied by a sutural bone. The greater part of the cranial cavity was filled with about 10 oz. of fluid lying in the subdural space. The brain (Fig. 3) was removed in its entirety by disarticulating the cranial bones. The medulla and pons were normal as were also the cranial nerves arising therefrom. The cerebellum appeared to have developed normally, but had been somewhat twisted to the right and was laterally compressed. This

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twisting became more noticeable in the mid-brain, the crura cerebri being turned clockwise through a quarter of a circle. The corpora quadrigemina were not prominent. The fore-brain was to a great extent suppressed. The optic thalami were flattened above and below, and from them a common optic tract ran forward to give rise to two optic nerves. An irregular cavity representing the third ventricle was present with a bundle of fibres, apparently the fornix, running into it from between the thalami. The roof was incomplete. The lateral ventricles and cerebral hemispheres were undeveloped and there was no trace of olfactory bulbs. The pituitary body appeared to be quite normal.

As will be evident from Fig. 4, the principal alterations in the skull occurred in the region of the face. Apart from the vaulting of the frontal and parietal bones, all the bones bounding the posterior part of the cranial cavity showed little change. Due to the approximation of the eyeballs, the frontal bones were considerably altered, their orbital plates lying in a transverse direction and forming with the up-curved presphenoid the posterior wall of the common orbit. The floor and lower rim of the orbit was largely formed by the two lachrymal bones which met in the middle line. The rim of the orbit was pierced on each side of the middle line by a foramen representing the osseous lachrymal canal. Just in front of the lachrymal bones a small elongated bone, obviously a nasal bone, lay between the two superior maxillæ. The pre-maxillæ were considerably distorted and formed the knob-like structure already mentioned at the anterior end of the palate. The two halves of the palate inclined upwards in the middle line forming a deep groove. The inferior maxillæ appeared normal in every way.

An interesting feature of this case is that the animal had lived for some time in spite of the fact that there was a complete absence of a nasal cavity.

The cause of cyclopia is now generally regarded as being due to some factor inhibiting the growth of the anterior part of the embryo in the very early stages of development. This is a most highly specialised area and contains the anterior end of the neural groove and canal which will separate the optic vesicles. According to the classical work of Dareste, " Recherches sur la Production Artificielle des Monstruosités," the cells in the middle line of the anterior end of the embryo and the tissues which develop from them should normally separate the two optic vesicles and by growing at the same rate as the vesicles should ensure the correct alignment of the eyes. If the growth of these cells is inhibited at this early stage the normal separation of the optic vesicles will not occur and they will grow towards each other in the middle line. Depending upon the degree of approximation, there may result two eyes lying together or only a single eye consisting of the fused temporal parts of the two original eyes. Accompanying these changes there would obviously

be a lack of development of the structures lying in the middle line of the anterior part of the head, thus the two sides of the face would come towards one another and the nasal chambers would be suppressed.

If this theory is correct, it appears that in this case all the structures in the mid-line of the head had, to a greater or lesser degree, been suppressed in early embryonic life, resulting in approximation of the two eyeballs and the absence of nostrils. The inhibitory influence, however, had not completely involved the nasal bones since there was a small nasal bone present. The aborted development of the fore-brain would appear to support the suggestion that there had occurred a very grave inhibition of the structures in the anterior part of the embryo.

TUBERCULOUS CEREBRO-SPINAL MENINGITIS IN A BOVINE

By J. F. CRAIG and G. O. DAVIES

In the Copenhagen abattoirs from 1907 to 1910, 0.53 per cent. of tuberculous cattle were found to present lesions in the nervous system. That such localisation is not rare is common experience, but it has not been so generally recognised that the frequency of the lesions in the spinal cord is only slightly less common than in connection with the brain.

Cerebro-spinal lesions are encountered most frequently in young cattle of one to two years old and generally coexist with other lesions amounting to generalisation of the disease.

The case which we desire to put on record was affected with tuberculosis of both the cerebral and spinal meninges and presented somewhat unusual symptoms, no doubt associated with the localisation of the tubercles. It was a pure-bred Friesian heifer about 18 months old which came under observation in April, 1939. The symptoms had been developing for a few weeks.

The animal was in poor condition and its abdomen was tucked up. The peculiar features about it were that it could not close the mouth firmly and three or four inches of the tongue protruded. The tongue was quite normal in form and consistence, but was brown where it was protruded and there was some dribbling of saliva. On manual examination it was found that the mouth was full of a tangle of long hay which the animal had picked up but was unable to masticate. This experience was repeated when hay was offered and taken by the heifer. It was therefore evident that there was some degree of paralysis of the muscles of mastication.

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In addition, during movement, there was some loss of control of the hind limbs and the animal walked as if affected with laminitis in the hind feet. The temperature throughout was normal. It was tested with tuberculin by the intradermal method but gave no reaction. In a few days it was unable to rise and ceased to feed. It was then destroyed.

On post-mortem examination the only lesions observed were those of tuberculosis. The pharyngeal, bronchial and mediastinal glands were enlarged and presented numerous small caseous areas. The pleura showed extensive layers of red granulation-like tissue with grape lesions in patches covering the costal and pulmonary pleura. The peritoneum was similarly affected, the lesions involving the abdominal wall and serous surface of the liver and spleen. The lungs showed a few caseous patches and there was a small caseo-calcareous tubercle in one of the mesenteric glands. There was also one small grey tubercle in the cortex of each kidney.

In the brain and cord there were numerous pinpoint grey tubercles on the pia mater along the base of the cerebrum, over the pons Varolii, medulla and over the spinal cord throughout.

On microscopical examination of sections of various parts of the pons, medulla, and cervical and lumbar portions of the spinal cord typical early tubercles were found in various parts of the pia mater. These tubercles were rich in giant cells and only in a few of them were there any necrotic centres. Some of the lesions were diffuse and invaded the outer coats of the arterial walls. At various points in the pons, medulla and cord the tubercles had extended into the underlying tissue and replaced the nerve fibres. Moreover, some portions of the spinal nerves and of the fifth nerve were involved and many of the nerve fibres had disappeared from them. These changes no doubt accounted for the symptoms of incipient paralysis of mastication and the paresis of the hind quarters shown by the heifer.

Tubercle bacilli were exceedingly numerous in the tubercles and in the giant cells. The exceptional richness of these tuberculous meningeal lesions in giant cells and tubercle bacilli in cattle as contrasted with their meagreness in human cases has already been noted by Ch. Besnoit in *Revue Vétérinaire* for October, 1906.

The infection of the meninges must have been secondary to the lesions elsewhere in the body and have entered through the blood stream. Large numbers of the bacilli must have reached the subarachnoid space and spread rapidly along the perivascular connective tissue of the meninges of the brain and cord. That could be the only explanation of the widespread distribution of these lesions which appeared to be at a similar stage of development.

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FIG. 1.—Head of heifer showing protrusion of the tongue and paralysis of the lower jaw described in the text.

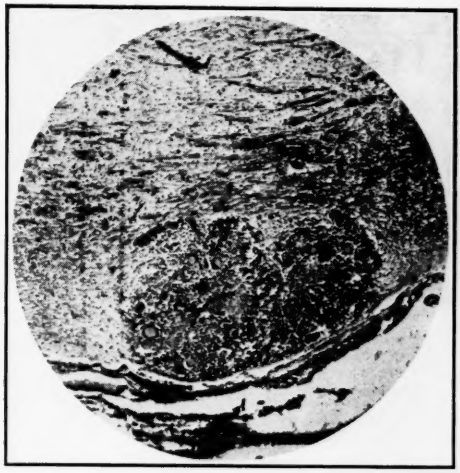

FIG. 2.—Section through pons showing tubercle nodule close to the pia mater. X 40.

FIG. 3.—Tubercle nodule from Fig. 2 more highly magnified to show numerous giant cells. X 100.

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ACROPACHIA IN THE DOG ASSOCIATED WITH PULMONARY TUBERCULOSIS

By J. F. CRAIG and G. O. DAVIES

FROM time to time descriptions appear in foreign journals of a condition described as acropachia, diffuse osteoperiostitis, hypertrophic osteoarthropathy or hyperplastic osteoperiostitis in the dog and less frequently in other animals. Lesbouyries (1926), in his monograph, "*La Tuberculose des Carnivores Domestiques,*" quotes Wirth as having observed 13 cases of this condition in 67 cases of tuberculosis in the dog. He also states that, although he himself could not give statistics, it is very frequent at Alfort. Other publications seem to lend support to the view that this condition is not uncommonly met with in the dog affected with tuberculosis, but so far as Britain is concerned records of its occurrence are very few. Smythe (*Vet. Rec.*, 1929, *9*, 421) and Wooldridge and Holmes (*Vet. Rec.* 1937, *49*, 508) described this condition in dogs, and the purpose of this note is to place on record another instance of its occurrence.

The subject was a two-year-old greyhound bitch and was received by us with a history that the swellings on the legs had appeared suddenly within a week of racing on the track. The bitch had, however, been losing condition for some time. When received she was very poor, but was bright and fed well. The limbs were diffusely swollen at the elbow joint and near the lower extremities of the radius and ulna. The swellings near the carpal, stifle and hock joints were very prominent, the hock lesion including the os and tuber calcis. The swellings were firm, painless and almost bonelike in consistence.

Post-mortem examination revealed areas of tuberculous broncho-pneumonia with vomicæ in several lobes of the lungs and a few small tubercles in the mesenteric glands. The heart was dilated and flabby and the valve cusps of both auriculo-ventricular valves were thickened. The liver, spleen and intestines showed evidence of venous congestion, but otherwise, as in the case of the remaining organs, they were normal.

Smears from pus in the vomicæ stained by the Ziehl-Neelsen method revealed numerous acid-fast bacilli, typical of tuberculosis.

The swellings on the legs appeared greyish in colour, were firm and closely attached to the bone. When cut they appeared like masses of dense fibrous tissue.

Histological examination of the lung tissue confirmed the presence of tuberculosis, but sections of the bone enlargements failed to reveal any suggestion of tuberculous infection. Representative portions of tissue from different situations showed the superficial parts of the lesion in each case to consist of dense fibrous tissue. When this fibrous tissue was removed by

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boiling, the underlying bone revealed the presence of diffuse osteoperiostitis. In some areas there were rough, irregular deposits of cancellated tissue, whilst at other points the bone had undergone rarefaction. (See photograph.)

The findings in this case lend support to the view that the changes affecting the limb bones, sometimes met with in dogs affected with pulmonary tuberculosis, are not tuberculous in nature, although they arise in association with this disease. It would appear from the literature that similar bony changes occur in man and they occur in a variety of conditions affecting the respiratory organs other than tuberculosis, e.g., bronchiectasis, empyema, malignant growths, etc.

Reports

Ceylon: Report of the Government Veterinary Surgeon for 1938.

In his report for 1938 (published in December, 1939), Mr. M. Crawford, M.R.C.V.S., Deputy Director (Animal Husbandry) and Government Veterinary Surgeon, discusses the various activities which come under the direct control of the Government Veterinary Surgeon, including the Government Dairy. He reports that "on the whole, the year was free from serious outbreaks of infectious disease." Foot-and-mouth disease incidence showed a decline and it is stated that the methods of control as applied to rinderpest are not applicable to foot-and-mouth disease but that "the most hopeful line of attack seems to be the discovery of some method of producing an artificial immunity which would protect valuable dairy cattle."

Among the items discussed is an apparently new disease of goats which is said to resemble in some respects "heart water" of sheep and goats in South Africa. Artificial insemination of cows is being practised to a small extent and it is hoped to carry out experiments to test the possibility of transporting semen over a distance. It is interesting to note that no cases of tuberculosis were found in cattle slaughtered at the various slaughterhouses.

Cyprus: Annual Report of the Veterinary Service for the year 1938.

The Chief Veterinary Officer (R. J. Roe, M.R.C.V.S., D.V.S.M.) deals in this report with the control of contagious diseases, the inspection of livestock prior to export, the quarantine control of imported animals, the registration and inspection of dairies and cowsheds, the supervision of meat inspection, the licensing of stallions, the veterinary attendance of police horses and Government-owned livestock and the assistance given to the animal husbandry branch.

Bones from limbs of greyhound showing lesions described in the text.

It is reported that the colony remained free of foot-and-mouth disease, bovine, pleuro-pneumonia, cattle plague, bovine tuberculosis, Bang's disease, dourine, glanders, swine fever, rabies and many other serious diseases which cause heavy losses in the neighbouring countries.

Anthrax is controlled by the use of vaccine and compulsory measures to ensure the proper disposal of carcasses. During the year, 567,959 animals were vaccinated. It is recorded that "insect and helminth parasites are now responsible for considerably heavier losses in livestock and animal products than those due to bacterial or virus disease." Treatments and preventive measures are carried out on a large scale. Laboratory work consisted mostly of the preparation of vaccine (mostly anthrax) and diagnosis work. Some experiments were carried out on the double vaccination of goats against anthrax.

Canada : Report of the Veterinary Director-General for the year ended March 31, 1939.

THE report (by A. E. Cameron, M.C., V.D., V.S.) is divided into two parts.

Contagious Disease Section.

There has been comparative freedom from scheduled diseases during the year and most of this section of the report deals with work on tuberculosis control. Under the accredited herd plan herds are accepted if they include at least five pure-bred cattle of one breed, registered under the name of the owner, and the number of registered cattle must constitute at least one-third of the herd. An accredited herd is one which has passed two clean tests with an interval of one year, or if infection is found, three clean tests with intervals of six months. During the year there were 9,414 herds under this plan, 8,529 of which were fully accredited. There were made 306,079 tuberculin tests and 2,291 reactors were found and slaughtered, compensation being paid.

A supervised herd plan is also in operation. Herds under this plan comprise those which do not qualify for the accredited plan. The animals are tested as above, but no compensation is paid for reactors although they must be slaughtered under supervision. In all, 49,445 herds have been tested under this plan. Restricted areas for the eradication of bovine tuberculosis are set up when two-thirds of the stockowners in the area petition for this to be done and the Dominion Minister concurs. Tuberculin testing becomes compulsory and reactors are slaughtered, compensation being paid. All cattle coming into the area, except those for immediate slaughter, must be accompanied by an official certificate of tuberculin testing. In all, 1,101,073 cattle were tested under this scheme during the year and 10,784 reactors were slaughtered.

Bang's disease is also controlled in the Dominion. Stockowners are

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assisted by having free agglutination tests carried out. Infected animals are slaughtered or segregated, according to circumstances. Animals are tested at short intervals until all positive reactors are removed from the herd. It is part of the scheme that qualified veterinary surgeons take the blood samples and send them to the laboratories for test. Following freedom from reaction for a year, a veterinary inspector of the Health of Animals Division makes a check test and if the herd is found free from reactors it is listed as a Bang's-disease-free herd. There are 2,019 herds, comprising 52,494 cattle, in the scheme.

Cattle for export to Great Britain are dealt with under the British Imporation of Canadian Cattle Order of 1933. They are isolated under supervision for 24 hours before shipment. Also, to protect Canadian export trade, all cattle for breeding or milk production are tested with tuberculin and a blood test for Bang's disease is carried out. Any cattle reacting to either of these tests cannot be exported from Canada.

Meat and Canned Food Section. (Report by C. Maconachie, O.B.E., M.C., V.S., Associate Chief Veterinary Inspector.)

During the year 41 shipments of fresh beef (1,025 carcasses) were shipped to the United Kingdom.

In all, 280 full-time employees of the Meat Inspection Section of the Health of Animals Division are engaged in meat inspection.

During the year 11,830 cattle carcasses were condemned (1.38 per cent. of the total cattle killed). The principal causes—emaciation and tuberculosis—accounted for 65.22 per cent. of the total condemnations. Of the calves slaughtered, 5,543 (0.82 per cent.) were condemned, mainly because of immaturity.

Concerning pigs, a total of 6,768 carcasses (0.22 per cent.) were condemned. Tuberculosis accounted for 37.20 per cent. of all the carcasses condemned and 72.91 per cent. of all portions condemned.

United Provinces: Annual Report of the Civil Veterinary Department United Provinces for the year 1938-39.

THIS report is prepared by the Director of Veterinary Services—T. J. Egan, I.V.S. It is divided into chapters. Chapter I deals with general administration and records visits paid by the Director and his staff. In Chapter II there is considered the treatment of diseases. It is stated that epidemics were severe, the mortality from contagious diseases increasing from 33,992 to 44,992, rinderpest and hæmorrhagic septicæmia being responsible for the increase. Among horses, losses from glanders, surra, anthrax, piroplasmosis and tetanus are discussed. The mortality among cattle from rinderpest rose, no district being reported free from the disease. The inoculation of tissue

virus was adopted as a routine measure for preventive purposes in most districts and experiments were carried out with the scarification method of inoculation with macerated chloroformed and unchloroformed goat tissue virus, in natural outbreaks. Encouraging results are reported. Hæmorrhagic septicæmia was prevalent and the losses from this disease had increased. Serum alone and vaccine were used. Foot-and-mouth disease caused fewer deaths than in the previous year. Blackquarter is being controlled by the use of serum alone and of vaccine, as is anthrax. Chapters III and IV deal with non-contagious diseases and veterinary hospitals. It is of interest to note that 529,761 cases were treated in veterinary hospitals and dispensaries.

In Chapter V is given an account of the laboratory and experimental work—routine examinations (1,147 in all); work on the attenuation of goat tissue virus for inoculation against rinderpest in buffaloes; study of the use of Naganol as a prophylactic for surra; Ranikhet (Doyle's) disease among poultry. These and other subjects formed the subjects of investigation. Other chapters deal with breeding operations, fairs and shows, etc.

Kenya : Veterinary Department Annual Report, 1938.

THE report by R. Daubney, O.B.E., M.Sc., M.R.C.V.S., is divided into eight sections. Section I deals with general subjects, including the livestock industry in 1938. It is of much interest to note that eight broadcasts were made by members of the staff, including the Director. In Section II an account is given of the control of disease in the settled areas and in the native reserves. Rinderpest was prevalent in some districts and it is believed that the most serious group of outbreaks originated through the illicit movement of infected trade cattle. Immunisation of cattle is carried out by the use of various methods, including serum and vaccine and virus. Other diseases are dealt with in this section. In Section III an account is given of veterinary education in Kenya. There are five training centres and a sixth is in course of preparation. Pupils are specially selected and undergo a short course of instruction, attention being paid to practical work. Some of the pupils after leaving the centre are employed by Government local native councils or European settlers. Most of them return to their homes and it is believed that the principles of animal husbandry which they acquire will be of benefit to the community in later times. Research work carried out at the Veterinary Research Laboratory, Kabete, is discussed in Section IV. The production of sera and vaccines was considerably increased, especially for immunisation against rinderpest. Routine diagnosis also occupied much of the time of the staff. Research work was carried out on the attenuation of various strains of virus by passage in goats and the effect of drying of the virus was studied. An investigation into epididymitis in bulls associated with vaginitis in female stock is in progress. Parasites and parasitic diseases have also been studied

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and the clearing of areas of species of *Glossina* by a combination of trapping and screen-catching has proved successful. Sterility in cattle in its various aspects has occupied the attention of some of the staff and experimental work on artificial insemination has been carried out on a small scale at the Experimental Station, Naivasha. Artificial insemination is also being practised on cattle and, to a lesser extent, on sheep, by farmers. In 1938, nearly 10,000 cows on 12 farms and about 4,000 ewes were artificially inseminated. Other sections deal with publications, statistical information, etc., and several instructive tables and photographs complete the report.

Reviews

THE American journal, *Veterinary Medicine,* is to be complimented on its policy of publishing in book form selected articles which have appeared in its columns from time to time. These small books, which contain an average of about 80 pages, are published at the uniform price of one dollar. They present recent information on the various subjects in a concise and readable form, thus offering, at a moderate cost, the results of research, or of practical experience to the busy reader who has neither time nor opportunity to search the literature for the original articles.

Canine Pediatrics. By D. M. CAMPBELL with the collaboration of G. C. SUPPLEE and J. H. LE WARE. Veterinary Magazine Corporation, Chicago, 1939. Price one dollar.

THIS book deals with the artificial feeding and rearing of young puppies, the various articles being based on the researches carried out over a period of fourteen months at the Borden Laboratories, Bainbridge, N.Y., by Dr. G. C. Supplee and his associates. After giving statistical evidence to show the high mortality rate among young animals of all species, and the unfavourable comparison with the mortality rate among human infants, the authors state that this is due to two main causes:

"(i) Proportionate funds for research have not been available.

"(ii) Such research as has been done has availed less because of the lack of a skilled personnel to put the newly discovered facts to a productive use; the economics of the situation being such that it was deemed necessary for the livestock owner to carry out scientific programmes without technical supervision."

Doubt is cast on "the premise that the stockowner cannot afford the guidance of the veterinarian in rearing young animals. Yet we pasture, house,

feed and care for 12 million brood sows to farrow 60 million pigs to market 40 million hogs—12 million sows doing a job for which five million are adequate." It would be truer to say that he cannot afford *to be without* such guidance.

The prevailing conditions of civilisation and the unnatural lives of town dogs are discussed as pre-natal causes which affect adversely both the breeding capacity of bitches and the unsuitability, in many cases, of their milk, both quantitatively and qualitatively, for rearing puppies. These factors have a direct influence on the mortality rate of the young during the first two weeks of life.

The scientific aspects of puppy nutrition receive full consideration, supported by experimental evidence covering the chemical and biological study of the question. A simulated bitch's milk has been evolved, details of which are given, and emphasis is laid on the importance of clinical observation as an index of progress of artificially fed puppies. Environmental factors are discussed. The interesting observation is made that artificially fed puppies no older than six to nine weeks respond to the human voice and presence to a degree which makes bitch-reared puppies appear almost dull and stupid by contrast. Practical directions for artificial feeding of puppies are given in the final article.

The authors state among their conclusions the following points:

> A satisfactory simulated bitch's milk has been evolved which is suitable for the artificial feeding of very young puppies. Many previous concepts of puppy feeding must be abandoned or revised.
>
> Clinical tests of the new feeding formula and technique definitely establish their soundness.
>
> The development of simulated bitch's milk is the foundation of a new specialised science of dog pediatrics.

Sheep Practice. By E. T. Baker and twenty-one collaborators. Veterinary Magazine Corporation, Chicago, 1937. Price one dollar.

The articles in this book range over a very wide field, covering sheep husbandry and practice in many of the States of the Union. Much of the information is of greater interest to American readers, but there is also much of wider importance which could be read with interest and profit by British veterinarians.

The first article deals with the anatomy of the sheep, more especially its application in practice. This is followed by an article on Laboratory Consultations which emphasises the essential team character of the relationship between the laboratory and field workers. Many useful hints are given on the selection and packing of specimens sent for examination, and on the compilation of full case reports to assist in diagnosis. Another article discusses

the Preparation of Ovine Biologics. A description is given of the United States Sheep Experiment Station near Dubois, Idaho, the object of which is to " furnish assistance to the sheep industry in the solution of problems relating to the improvement of range sheep for the efficient production of superior wool and meat." This station is used by the United States Department of Agriculture. From an inset headed Sheep Research we quote the following: " A corps of professional workers should include a botanist, a forester, a chemist, a veterinary pathologist, a veterinary bacteriologist, and a field veterinarian to handle the clinical part." The Control of Sheep Parasites receives attention in a practical manner, while among Some Diseases of Feeding Lambs we note references to overeating, braxy-like diseases and coccidiosis. Other articles discuss sheep husbandry in the different states, Wisconsin, California and the Middle West as well as Mexico. Interspersed between the main articles are many short paragraphs containing in a few sentences some essentially practical hint, or the results of some piece of research. It is a delight to read these paragraphs for they serve to stimulate one's mind along many and diverse avenues.

NOTE.—In this series a review on " Poultry Practice " was published in the March, 1940, number of THE VETERINARY JOURNAL. Reviews of further books in the series will follow.

Anthrax in the Blue Fox. By E. Hoffman (1940). *Skand. Veter.-Tidsk.*, XXX, 161. (Author's Summary in English.)

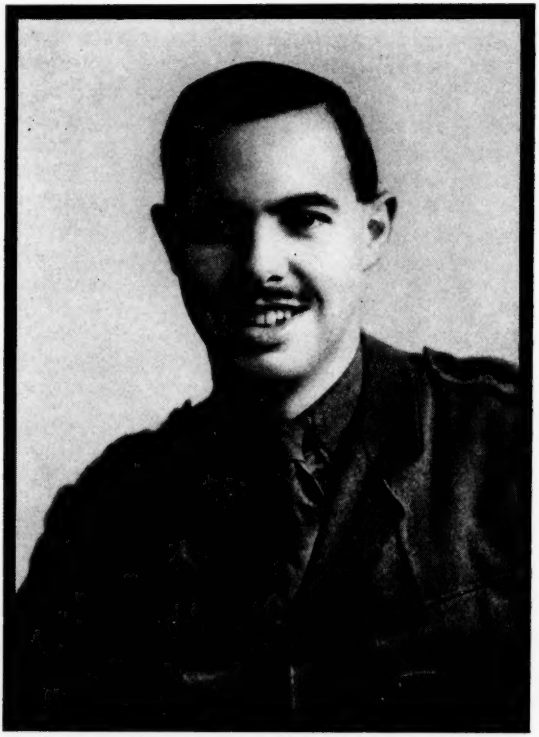
THE author describes an outbreak of anthrax among blue fox, caused by feeding with raw meat of a cow which had died of anthrax.

The cow, which had been bought quite lately, died suddenly five days after the purchase. A slaughterer was called in and he removed the stomach and intestines, which he then buried. The meat was afterwards sold to a fox farm where there were about 350 blue foxes.

The lungs, heart, liver and meat of this cow were minced in a mincing machine, and the minced meat was mixed with a boiled porridge made of meal and milk, the food then being given to all the foxes.

Four days after the first meal of this mixture three foxes died; two days afterwards two more foxes died; two more died the following day; three died the day after this, and one more the next day; altogether, 11 foxes in six days.

On a post-mortem examination of the first two foxes which had died it was found that they had died of anthrax; this diagnosis was confirmed by culture of the *Bacillus anthracis* at the State Veterinary-Bacteriological Institute, in Stockholm.



STAFF CAPTAIN EDWARD A. W. B. DIXIE

The body of the dead cow which had been purchased was found, on bacteriological examination, to be that of an animal which had died of anthrax.

The skins and bodies of the foxes which had died of anthrax, together with the remains of the cow which had died of the same disease, were burned. The fox farm was afterwards disinfected, and the disease disappeared.

Most of the foxes which had died showed no clinical symptoms. Others displayed severe symptoms of dyspnœa, with audible, hissing breathing, which soon ended in death.

On a post-mortem examination, blood-stained œdema was observed around the larynx, together with enlarged spleen containing large numbers of anthrax bacilli.

The author points out that blue foxes appear to possess great power of resistance against anthrax infection *per os*. In no instance did more than one animal die in each cage.

In a note to the above work, the author describes a B_1-avitaminosis at the same fox farm, the course of which was characterised by symptoms of paralysis. These symptoms disappeared rapidly after injection of aneurin (= thiamin chlorid).

OBITUARIES

STAFF CAPTAIN E. A. W. B. DIXIE

Edward Dixie made the great sacrifice on May 25 at Cassel, about twenty miles inland from Dunkirk. He was Anti-Tanks Officer to the 145th Infantry Brigade (Oxford and Bucks).

Capt. Dixie was a student of the Royal Veterinary College, having passed his third examination in July, 1939. He was a Territorial Officer and as such was mobilised on the outbreak of war. Whatever the task in hand, Dixie would bring all his energies to bear upon it and he entered the new field of endeavour with all the zest which he had displayed in his academic career. I well remember a visit which he paid to the College soon after the outbreak of war, when filled with enthusiasm he told us how his unit had shot down a "Queen Bee" at a practice shoot.

His regiment was holding a position in the village of Cassel. They were attacked by a large force of enemy tanks on the morning and afternoon of May 27. Capt. Dixie was firing a gun himself and every time he hit a tank he stood up and cheered. In his adjutant's words: "He put up a truly magnificent show, his guns accounting for a large amount of enemy tanks." This is exactly what I should have expected of him.

Finally, when moving out for a rest he was hit by a bullet in the back of the head. He lived for about half an hour and was able to give his batman the following message: "Give my love to mother and tell her I died as I wanted to, in action."

Capt. Dixie was twenty-three years old, and his life was full of promise of great things. He will be deeply mourned by staff, students and lay personnel of the College, for he was kind and courteous to all. The country and the profession can ill afford to lose such men, and to his mother we express our deepest sympathy. No better epitaph can be given to this young man than that of his own batman who in a letter to me says: "I was with him to the last. He died a great gentleman."

J. McC.

R. L. CORNELL, B.Sc., M.R.C.V.S.

As we go to press we learn of the sudden death of Mr. R. L. Cornell, B.Sc., M.R.C.V.S., who died at Bangkok, Thailand, on August 4. Mr. Cornell was at one time a member of the staff of the Institute of Animal Pathology, Cambridge, which he left on being appointed Research Veterinary Officer, Tanganyika Territory. In 1937 he was appointed Veterinary Adviser to the Government of Siam.

Publishers' Notices

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